IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

NAKAMURA, Keishi et al

Serial No.: **09/825,446**

Filed: **April 4, 2001**

Group Art Unit: **2832**

Examiner: **Karl D. Easthom**

P.T.O. Confirmation No.: 1801

For. **LOW RESISTANCE VALUE RESISTOR**

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
Washington, D.C. 20231

Sir:

I, Keishi Nakamura, a citizen of Japan, residing at Tomigata 7417-3, Ina, Nagano, Japan, and an inventor of the present invention, hereby declare and state the following:

1. I graduated from Toyohashi University of Technology of Aichi, Japan in 1995 with a degree in master course of material science.

2. Since 1998, I have been employed by KOA Corporation of Nagano, Japan, where my present title is an engineer. During my employment therein, I have conducted mainly developments of low resistance value resistors.

3. I am familiar with the above-identified patent application as well as the Official Action of March 1, 2002, in the application.

Action of March 1, 2002, in the above-identified application.

5. Under my supervision and control, tests were conducted on (a) welding samples made by conventional welding method as shown in attached drawings and (b) diffusion-bonding samples according to the present invention made by diffusion bonding method for forming the diffusion layer by applying heat and applying pressure uniformly all over the electrodes as also shown in the attached drawings.

Welding samples are made by affixing a metal strip on both ends of the resistor body by welding wherein two points in each metal strip are welded by using a welding electrode with two pulse currents.

Diffusion bonding samples are made by attaching a sheet of resistor body (Cu-Ni Alloy) and a sheet of metal strip (Cu) (superposed); heat and pressure are applied uniformly all over the attached sheets for resistor body and metal strips, thus the sheet for metal strip is bonded to the sheet for resistor body with forming the diffusion layer at the interface thereof; unnecessary portion of metal sheet is removed, then a pair of metal strips is formed on the resistor body at both ends thereof as electrodes; and the sheet for resistor body having metal strips thereon as electrodes is cut into pieces of a suitable length.

6. The following experimental evidence was obtained from these tests:

In particular, Test result 1 shows evaluation of initial resistance value after completion of 2mΩ resistor. The result shows that sample resistors of the present invention (Diffusion-bonding method) have very small variations in initial resistance value

while sample resistors of the conventional welding method have large variations in initial resistance value.

Test result 2 shows evaluation of resistance variations by short-time overload test. The result shows that sample resistors of the present invention (Diffusion-bonding method) have very small variations of the resistance value while sample resistors of the conventional welding method have large variations of the resistance value.

Test result 3 shows evaluation of resistance variations by heat cycling test. The result shows that sample resistors of the present invention (Diffusion-bonding method) have very small variations of the resistance value while sample resistors of the conventional welding method have large variations of the resistance value.

7. From the above test results, I have concluded that resistors according to the present invention made by a diffusion-bonding method have very small variations of the resistance value, while resistors made by conventional welding method have large variations of the resistance value. That is, according to the present invention, remarkably decreasing variations in the resistance value can be obtained.

The undersigned declares that all statements made herein of his own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that willful false statements may

jeopardize the validity of the application or any patent issued thereon.

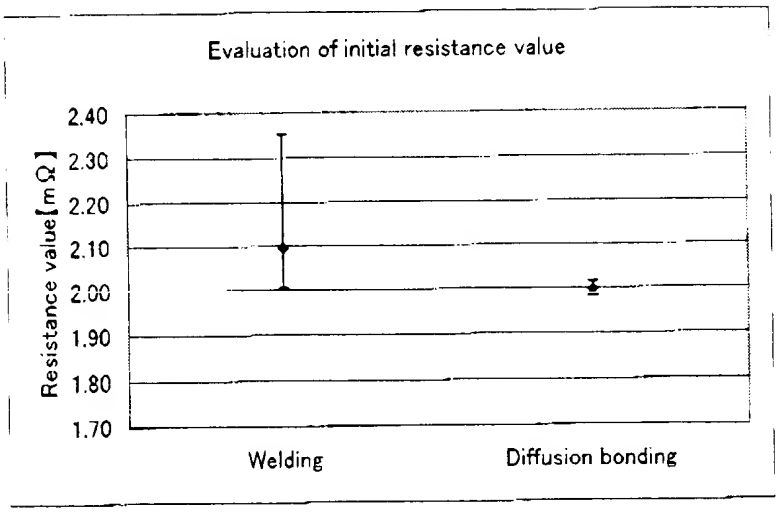
Signed this 24th day of July, 2002.

Keishi Nakamura

DWH/rab (010481)
Attachments: 5 pages of drawings and data

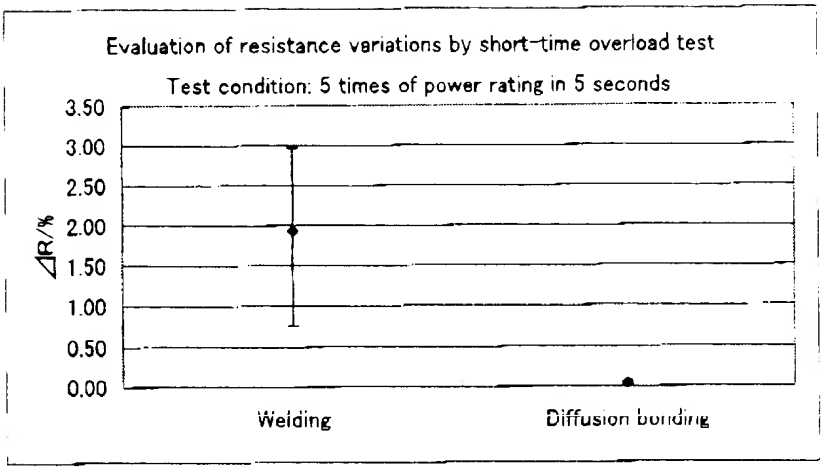
EXPERIMENTAL EVIDENCE

Test result 1



No.	Welding [mΩ]	Diffusion bonding [mΩ]	No.	Welding [mΩ]	Diffusion bonding [mΩ]
1	2.0163	1.9915	21	2.0661	2.0019
2	2.0097	1.9911	22	2.0344	2.0142
3	2.0044	1.9921	23	2.1514	2.0011
4	2.1465	2.0017	24	2.1224	1.9913
5	2.0754	2.0011	25	2.1394	1.9921
6	2.1734	1.9992	26	2.0884	1.9907
7	2.123	1.9887	27	2.1001	2.0041
8	2.1272	1.9965	28	2.0459	1.9903
9	2.144	2.0001	29	2.0594	2.0129
10	2.0746	1.9929	30	2.1306	1.9935
11	2.1014	1.9914	31	2.0382	1.997
12	2.0496	2.0012	32	2.0275	1.9994
13	2.0858	1.9832	33	2.0681	2.0004
14	2.1206	1.997	34	2.0872	1.9828
15	2.1087	1.9907	35	2.1244	1.9874
16	2.158	2.0068	36	2.0559	1.9946
17	2.0943	1.9994	37	2.0933	1.9982
18	2.0516	2.006	38	2.0768	1.9883
19	2.0701	1.9907	39	2.0966	1.9895
20	2.1493	1.985	40	2.3515	1.9877
			Ave.	2.0960	1.9956
			Max.	2.3515	2.0142
			Min.	2.0044	1.9828
			σn-1	0.0600	0.0074

Test result 2



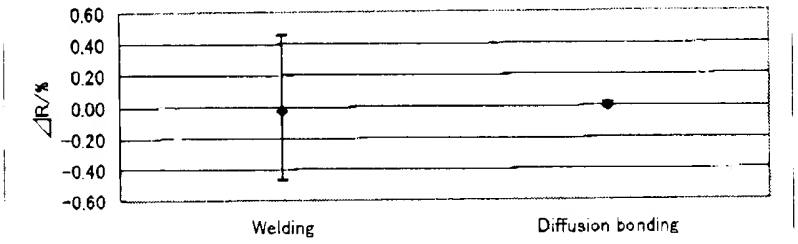
No.	Welding		
	Initial resistance(mΩ)	Resistance after test (mΩ)	⊿R/%
1	2.1377	2.2006	2.94
2	2.0578	2.1164	2.85
3	2.2041	2.2206	0.75
4	2.1876	2.2282	1.86
5	2.2138	2.2585	2.02
6	2.1514	2.1784	1.25
7	2.1544	2.1855	1.44
8	2.0824	2.1444	2.98
9	2.123	2.1642	1.94
10	2.1616	2.1895	1.29
Ave.	2.1474	2.1886	1.93
Max.	2.2138	2.2585	2.98
Min.	2.0578	2.1164	0.75
σn-1	0.0499	0.0415	0.7799

No.	Diffusion bonding		
	Initial resistance(mΩ)	Resistance after test (mΩ)	⊿R/%
1	2.0322	2.0331	0.04
2	2.0316	2.032	0.02
3	2.0249	2.0252	0.01
4	2.0431	2.0443	0.06
5	2.0405	2.0416	0.05
6	2.0434	2.0438	0.02
7	2.0261	2.0263	0.01
8	2.0386	2.0391	0.02
9	2.04	2.0404	0.02
10	2.0324	2.0331	0.03
Ave.	2.0353	2.04	0.04
Max.	2.0434	2.04	0.06
Min.	2.0249	2.03	0.01
σn-1	0.0068	0.0077	0.0200

Test result 3

Evaluation of resistance variations by heat cycling test

Test condition: −55°C (30min) / +125°C (30min)



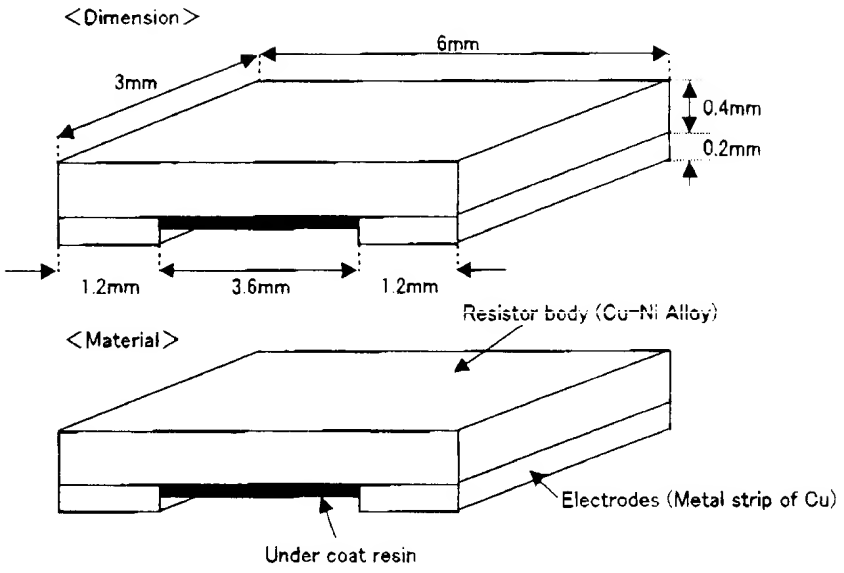
Test condition −55°C (30min) / +125°C (30min)

No.	Welding		
	Initial resistance(mΩ)	After 50cyc	
		Resistance after test(mΩ)	ΔR/%
1	2.0729	2.0773	0.21
2	2.0883	2.0872	−0.05
3	2.0603	2.0697	0.46
4	2.2178	2.2074	−0.47
5	2.1514	2.1449	−0.30
6	2.2385	2.2363	−0.10
7	2.1642	2.1559	−0.38
8	2.1889	2.1896	0.03
9	2.1988	2.2067	0.36
10	2.135	2.1359	0.04
11	2.1617	2.1577	−0.19
12	2.0983	2.1000	0.08
Ave.	2.1480	2.1474	−0.03
Max.	2.2385	2.2363	0.46
Min.	2.0603	2.0697	−0.47
σn−1	0.0582	0.0555	0.2842

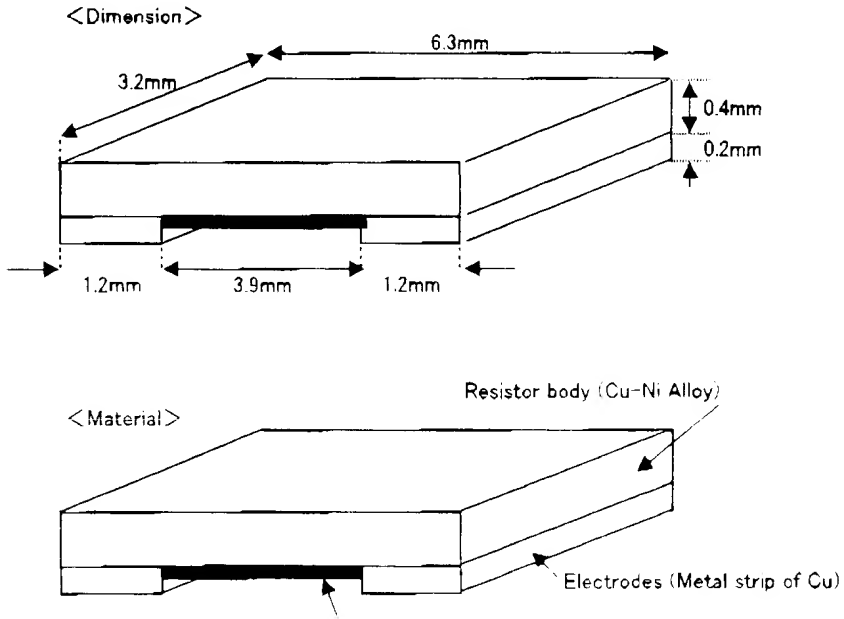
No.	Diffusion bonding		
	Initial resistance(mΩ)	After 50cyc	
		Resistance after test(mΩ)	ΔR/%
1	2.0572	2.057	−0.01
2	2.0589	2.059	0.00
3	2.043	2.0429	0.00
4	2.0574	2.0576	0.01
5	2.0515	2.0516	0.00
6	2.0688	2.0687	0.00
7	2.0676	2.0676	0.00
8	2.0706	2.071	0.02
9	2.0477	2.0477	0.00
10	2.0481	2.048	0.00
11	2.0651	2.0652	0.00
12	2.0814	2.0813	0.00
Ave.	2.0598	2.0598	0.00
Max	2.0814	2.0813	0.02

Samples

1. Welding samples

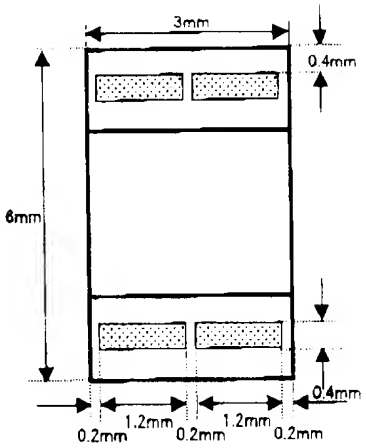


2. Diffusion bonding samples

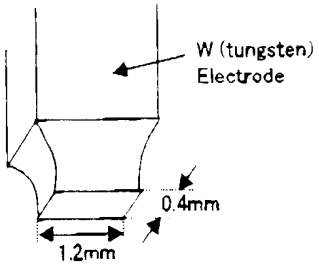


3. Method of welding

<Welding positions>

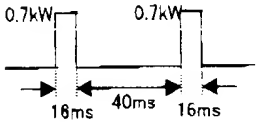


<Structure of welding electrode>



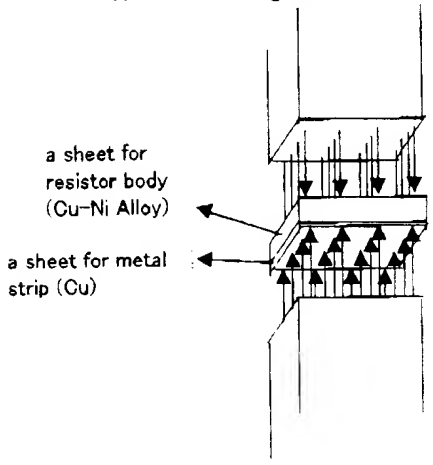
Welding condition

2 pulses



4. Method of diffusion bonding

<Diffusion bonding of the metal sheets>



applying heat and pressure uniformly all over the attached sheets for resistor body and metal strip, thus the sheet for metal strip is bonded to the sheet for resistor body with forming the diffusion layer at interface thereof.

<forming a pair of electrodes by removing unnecesary portion of metal sheet>